THE SOURCE OF CIVILIZATION IN THE NATURAL SELECTION OF COADAPTED INFORMATION IN GENES AND CULTURE

by Ralph Wendell Burhoe

In concluding this issue featuring Donald T. Campbell's presidential address to the American Psychological Association, "On the Conflicts between Biological and Social Evolution and between Psychology and Moral Tradition," I have been tempted to defend his primary theses by correcting the multitudinous errors that I see in the negative responses published in the May 1976 issue of the *American Psychologist* and elsewhere. To me, most of the negative responses evidence a failure to read Campbell with sufficient care or with sufficient background in recent interdisciplinary developments of evolutionary theory to be able to understand fully or correctly what he is saying. But republication of his address in *Zygon* demands a more positive response, for Campbell's paper conforms with and amplifies our basic hypotheses that have been reiterated in editorials and papers for more than ten years.

Also, Campbell's presidential address may mark a new age in the history of psychology and of psychotherapy. Speaking "from a scientific, physicalistic (materialistic) world view," he has pointed to how a most plausible and hardheaded science of human behavior can embrace in a coherent and empirically validated conceptual system a spectrum of data that ranges from the DNA substrate of organism at one extreme to religious myth and theology at the other. He has pioneered in the seemingly impossible synthesis of this broad range of intellectual perspectives upon human behavior. To some it is fright-

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eningly incredible or incomprehensible. At one extreme, his use of the genetic mechanics prohibiting altruism may symbolize the lowest level of reductionism beyond the pale of psychology even for most of those in the biobehavioral wing. The opposite extreme, pointing to scientific grounds for the essential validity of what currently appear to many as "insubstantial" religious myths, is likewise beyond the pale even for most in the humanistic and social wing of psychology.

I believe there is a high probability that further studies will justify the hypothesis of the connectibility of these extremes under a putatively common selective system. Such a selective system has been postulated by a number of scientists as the intrinsically steady states of natural systems as they evolve hierarchically.[1] These naturally stable states of subatomic particles constitute atoms, of atoms constitute molecules, of molecules constitute complex molecules, of complex molecules constitute living cells, of living cells constitute organisms, of organisms constitute species, of species constitute ecosystems. J. Bronowski has suggested intriguingly that random variations of elements at previously attained levels of this hierarchy of structures are exactly what force the emergence or development of the next level of stability or "being."[2] B. F. Skinner has noted that this kind of selection operates not only in the phylogeny of the evolution of species but equally in the ontogeny of human behavior.[3]

While a scientific understanding of the integration of the levels of cybernetic mechanisms of complex systems is not yet too far along, there would seem to be sufficient promise to justify Campbell's suggestion that our understanding of human behavior thus may be extended in a scientific system, map, or model that actually embraces the wide range from genes to religious culture.

For psychology, the development of a comprehensive and coherent theoretical model could mean the beginning of the end of the different "cultures" that segregate psychology into different university departments and buildings as well as into discrete societies and journals that have little in common intellectual structure beyond their claim to be describing some aspects of human experience/behavior. Much more than that, it could mean the beginning of psychology as *a science* in the usual sense of a discipline possessed of an empirically validated theoretical structure which can indeed explain or account for and not simply describe, categorize, and correlate patterns of human experience/behavior.

For the general culture, the development suggested by Campbell could mean a more effective science for application to psychotherapy or the "cure of souls," since it would encompass a wider range of the actual individual and social requirements for viability or well-being.

At present, psychology might be said to be a bird with two wings —one biological and the other sociocultural—but the bird cannot coordinate the two wings sufficiently to fly much above the empirical ground level of some interesting categories of often not too high correlations between inputs and outputs of some obviously not homogeneous black boxes. I think Campbell shows realistically how psychology might become the integrating link between man's biological and social natures.

My strong espousal of Campbell's address is because of his largely sound and interdisciplinary scientific extension of the analysis of human behavior from a central position in psychology to integrate with the analyses provided in terms as basic as genetics on the one side and as high as religion on the other. I am not saying that each one of his many suggested conceptual details is a final picture. His own cautious statements in his address and his tentativeness in personal discussion make it clear to me that he is more skeptical about some of them than I am. While I would challenge a number of points, including a small misinterpretation of something he attributes to me, all these would be picayune relative to the major sweep of what his address accomplishes, and I will not discuss them here.

But, since his address covers an area in which I also have been working for some decades, I should like to provide some additional support for his general position, as some of the other authors in this issue have done. I shall seek to extend Campbell's schema further in each of the directions in which he has pushed from the psychosocial center.

Since my primary concern is one of constructive understandings of religion and advancement of its salvatory functions in the light of the sciences, I shall seek to extend and go beyond his interpretation of religion's function to provide a socially cooperative behavior that genes alone cannot accomplish. I shall propose a mechanism to explain how religion's function to catalyze cooperative social behavior in fact can be selected in a "culturetype" (the human societal organism's analogue of a genotype), when such behavior cannot be selected in a genotype (the genetic recipe for an organism). I shall go further to show that, as in biology there have been selected mechanisms to give pleasure as well as pain, so there has been selected in the sociocultural evolution of religion a pleasant, hopeful, promissory aspect as well as a fearful and inhibitory aspect and that the former aspect is even more effective to generate cooperation. Also, I shall suggest an explanation of why we may say that even the "intelligent" variations —the varied, conscious decisions of men, which Campbell says (but many of his critics failed to note) are a part of the diversity upon

which the natural-selection analogues of sociocultural evolution operate[4]—are themselves tantamount to "blind variations" among which in the end a more-than-human *nature* selects, no matter how conscious, rational, or even scientific the humans may be in their choice making.

In the other direction I shall seek also to extend the integration of Campbell's model even beyond the information encoded in the DNA of the genes to the prebiological cosmos, that is, into physics. By this extension I shall go further than Campbell does. Not only shall I assert the functional utility of religion for social cooperation, I shall move toward demonstrating that the conceptual schemes or myths of religion—about superhuman gods who punish the doers of certain evils and reward the good—that have been selected in cultural evolution are perhaps truer, not only more necessary for societal functioning but also more valid as "ontological" hypotheses, than most modern intellectuals have supposed. This will bring my extension of the conceptual scheme full circle around the world of man's conceptual thought to the antipodes from where Campbell writes of the psychosocial sciences to where theology and physics are found merged in a *pacific* ocean. I seek to present a world map where all realms of man's "vocabularies" are represented on the surface of a coherent globe of man's cognitive experience, through and around which there are multitudinous potential lines of logical connection.

I shall go so far as to suggest that not only was it necessary and valid for the selection processes in sociocultural evolution to produce the religions it did in order to generate cooperative behavior functional for human society, since genes alone are incapable of generating it, but that it was necessary for the selection processes of sociocultural evolution to develop those religions in the ways and in the times they did—prior to the flowering of the brain and culture to produce conscious, rational, and scientific thought—in order to make possible the flowering of recent high civilization.

At the same time I shall point out that the rapidly declining power of religion in the world today to provide the necessary understandings of the self in the scheme of things, in order to generate sound psyches and motivate adequate morals for a civilized society, stems from religion's lack of a theology or system of understanding that is coadapted with contemporary scientific information. I shall seek also to show that the secular and political philosophies are relatively impotent to do this because they are not, as religions have been, coadapted with the information in the human gene pool through ancient ritual ties to the lower, more specifically genetically programmed levels of the brain.

I believe this picture will show that our twentieth-century crisis in human evolution is either a stress that will *select against* most contemporary sociocultural systems and possibly bring on a much more catastrophic Dark Ages than those after the fall of Rome or, if our readiness to adapt can become consciously motivated in time, a stress to move us to avoid the slower and more painful processes of prior levels of sociocultural evolution and enter more immediately into a new level of sociocultural evolution guided by a *coadapted science and religion.* The latter is something which Greco-Roman civilization almost, but not quite, succeeded in accomplishing in time to avoid its fall. In either case, I believe there will emerge a new coadaptation of science with religion, analogous to the synthesis of neo-Platonism and Aristotelianism with a Jewish religious cult, which, I have suggested, made Western theology the ground for Western civilization and science.[5] Our similar problem now is how to provide morals for society and meaning for psyche by a proper coadaptation of science and religion today before Western and dawning World civilizations collapse.

Zygon for more than ten years has been affirming that the time has come when the sciences can provide new light on religious questions and human salvation, that there is at hand a new "revelation" for religious truth. This means that effective theologians, like effective psychologists and psychotherapists, need to become aware of new knowledge from whatever scientific disciplines that may illuminate our understanding of human nature and its place in the scheme of things. This may require some technical information of new kinds to be integrated within the corpus of both psychology and theology.

A Note on the Nature and Use of Scientific Knowledge

In his introduction Campbell pointed to a limitation on the experimental method in the arena of psychology and psychiatry that prevents them, relative to some other sciences, from advancing more rapidly to truly assured doctrine. He has suggested that, if traditional religious recipes for living have undergone a long period of winnowing by nature's selective processes of what really works, as has genetic wisdom, perhaps we have at hand a truth and wisdom about and for human behavior that is more adequate than some of the speculations of the psychosocial sciences in the past century.

Here we may say he was implying that when scientific theory cannot be checked or validated for soundness by experiment it may be validated by observation. In astronomy some of our most valid science arose without man's being able experimentally to manipulate the variables involved in the motions of the planets. In evolutionary

theory about the origins and development of the earth, chemicals, and species we have built up a very significant body of assured doctrine about events in a time prior even to our capacity to observe what was going on, to say nothing about our experimentally manipulating any of the variables. While suitable experimental manipulation and/or wisely selected observations of certain of the variables under suitable conditions have provided confirmations of our scientific theories (conceptual structures or symbolic models) of the real world, it is not always necessary to be able to experiment or even to observe an action or entity to have relatively sound knowledge about it and its history. If from other sources we already have a well-validated model, we can, by operating the proper logical (mathematical) formulas in a brain or a computer, derive from limited observable elements certain conclusions about a more complex system that are as sound and true as our model is valid, as the Greek geometers long ago discovered. Central to scientific as well as to genetic information is a tried and tested model of the real world.

What I am seeking to suggest to theologians is that the wide-ranging, partially integrated models of the contemporary sciences have built an understanding of the nature of cosmic and human history that far exceeds the scope of any previous revelations. Furthermore, I am suggesting that proper attention to the wider ranges of scientific knowledge as they disclose man's nature and place in the scheme of things may provide theologians with a new hermeneutic, allowing them to correlate scientific understanding more effectively with the cumulation of earlier religious revelations of the sacred. From my first editorial in *Zygon* I have claimed that the new hierophanies potentially provided by the light of the sciences will not so much destroy the traditional ones as enhance them. This has been a traditional claim of many reformers and advancers both of religion and science. It is to such a humility and genuine respect in the presence of the long-evolved and well-winnowed wisdom of previous doctrines of man and his salvation that Campbell calls his colleagues in the name of a more scientific stance.

The Brain as the Yoke That Binds Genes and Cultures

To understand the conversion of a genetically selfish animal into a cooperator in the world's first widely extended cooperative societies (some of them nearly species-wide, so far as their sampling of the range of the human gene pool is concerned), an understanding of the brain is central. R. W. Sperry has reminded us that the central agency

in human behavior, feeling, and thinking of all kinds is the brain.[6] E. O. Wilson at the end of his monumental *Sociobiology* has suggested that a coalition of biogenetics and neurophysiology probably will be necessary for a science of society.[7] For decades Hudson Hoagland has been telling theologians and philosophers that religion is an almost inevitable result of the way the brain has evolved to provide viable organic responses to internal and external conditions. The brain is an organ of survival established by biological evolution. Its main function has been to enable the organism to integrate both external and internal sensory information into configurations that will enable the organism to adapt and remain viable: "The ability to form meaningful configurations that encompass large segments of the environment [what Wilson calls 'tracking the environment'] is a property of the more highly developed brains, and a good case can be made for the view that man's concerns with science, philosophy, political ideologies and theologies are a reflection of a basic property of his nervous system to integrate extensive configurations relating himself to his environment."[8]

The brain's activities are structured in two ways. First, the brain is structured from the inside out by the genetic code inside each of its ten billion cells. This code contains a memory of successful ways to live, culled or selected from a long history of life in past environments. The memory units have been integrated or coadapted with one another and relative to a wide range of internal and environing circumstances.

Second, the brain's activities are structured from the outside in by all the messages received from its environment, beginning during its development in embryo and continuing until death. In the human brain there is a special genetic adaptation thus to receive a large block of information from a specially structured, living record of cultural information, environmentally stored in the "social organism" and its artifacts, a new "supraorganism" with which each human has become symbiotic and on which he is dependent for his life. This cultural input is the socially transmitted patterning of the mores or traditions of a society which takes place in accord with special sequences of enculturation. Both prelinguistic and linguistic information are transmitted this way. Recent ethology and psychology have shown how these inputs must be in phase with a hierarchy of levels of development or maturation of the brain, beginning with early "imprinting," through social conditioning or reinforcement, to later reasoning. George Edgin Pugh has given a well worked-out picture of the human brain as the central agent in our "value-driven decision

system" and has called the genetically determined values our "primary values" and the values shaped by the input to the brain from the outside our "secondary values."[9]

Paul D. MacLean has shown that our brains are structured in three layers which originated in three different periods of our evolution.[10] The first and lowest level he calls our reptilian brain because it originated when our ancestors were reptile-like creatures. From the brains of contemporary reptiles and other evidence we know that this level of the brain contains the basic mechanisms which produce automatic or instinctive behavior to keep the animal (including the human animal) alive and in good condition. It seems to be *basic* for most of our higher responses, or our motivations in response, to messages from our inner states as well as from our environment. Its nearly automatic response patterns to certain kinds of messages from the environment provide the basis for ritual (behavioral or prelinguistic) communication. Genetic selection has insured that our reptilian brain automatically produces behavior that statistically is geared to enhance life. We do not become conscious of much of this behavior, in ourselves even, until we begin to study scientifically the various mechanisms involved.

The second major level of the human brain's structure and behavior MacLean has called our paleomammalian or old mammalian brain because it originated in and still resembles the brain structures and functions that began to cover the reptilian neural structures as the mammals emerged in evolutionary development. This mammalian brain provides a more generalized picture of the self in relation to the environment together with suitable emotions or feelings that provide a more generalized guide for directing behavior than the more tightly prescribed, automatic responses provided by our reptilian brain. It provides the mechanisms that produce our feelings of fear and love toward prospective conditions, on the basis of which we can choose alternative courses. This old mammalian brain level in man appears to integrate information from the inside of the organism (including its various needs) with information from the outside world (with its various opportunities for satisfying needs) and to be "essential for a feeling of individuality and personal identity."[11] These feelings are basic to our religious and moral responses toward right and wrong.

The third level of the human brain is the neocortex, which has developed phenomenally in *Homo* during the last million years and made it possible for man to be different from all other creatures. The development of the neocortex is *genetically* so structured that the *genotype* provides a still more loosely coupled and more generalized control of behavior than the mammalian brain in response to infor-

mation from the sense organs of the world within and outside the body. There seems to be good evidence that this outer cortex or "bark" of the brain provides for the ready reception with significant meaning of more complex prelinguistic and linguistic symbols from the environing culture. It provides for the association of these symbols with the underlying organic or ritual meanings aroused in response to patterns of our outside and inside worlds received from our various senses and given varied affective tone through connections in the mammalian and reptilian levels of our brain. The neocortex also provides us with a neurological mechanism for complex elaboration and logical manipulation of symbolic structures which we call ideas. The mechanism for manipulating ideas or symbols includes ways of projecting them against the patterns of remembered ideas from earlier experiences as well as against the genetically and culturally prescribed norms that have been inscribed previously in the central nervous system. On the basis of a genetically and culturally inscribed program for computing consequences (akin to the consequences of moves on a chessboard), the symbols can be manipulated to relate a current sequence to a potential future sequence, and, insofar as the models in the brain conform to the real world, we can bring possible future states into our present decisions—a matter of great importance to religion. These mechanisms embrace our emotionally conditioned and genetically programmed instinctive needs that motivate our choices. By making possible linguistic communication, the neocortex provides a new level of social transmission of culturally evolved and inherited information that has greatly enriched our genetic heritage.

These three levels of brain under proper enculturation of the neocortex are coordinated and produce harmonious hierarchical operations of behaviors, feelings, and capacities for rational thought that allow our living to be directed simultaneously by genes, the world, and society. But it is also important to note that they are all heavily interconnected and work together in what might be called a coadapted, interdependent fashion. It is such a relationship that provides an explanation of the psychosomatic relationship between physiological behavior and states of mind. The recent addition of the new cortex in man also permits an explanation of how man can be programmed simultaneously by his own basic and bodily needs as registered in his genes and his reptilian brain and yet also by the highly complex patterns of social cooperation that can be enculturated through the outer cortex into almost "instinctive" self-giving to the sociocultural system. It is this evolution of the outer cortex of the human brain that is necessary to explain how human evolution emerged to a new level of life above that of all other creatures on

earth and why man is the first to be able to motivate social cooperation with non-kin segments of the same species.

The Genetic Problem

But how could the genes structuring the brain evolve this way if it is true that the natural selection of alternative alleles cannot favor a competing genetic heritage? I have long shared the understanding presented so dramatically in Campbell's paper that biogenetic evolution by itself cannot produce self-giving behavior that benefits other individuals who are in genetic competition. I shall make it clear at the outset that for my doctrine of man for a scientifically credible theology I find it even more important to accept the stark genetic model presented by George C. Williams than does perhaps Wilson for his sociobiology or Campbell for his biosocial psychology.[12] My grounds for this derive in part from the new information on the brain as well as from reflection on the problems of historical theology and the evolution of religion. I shall develop my reasons for understanding the evolution of religion, more or less as sketched by Campbell, as the "missing link" for understanding how apemen became human. This in turn leads me to an understanding of why men must continue to cultivate a higher level of religion with a credible theology if they are to remain human in a sociocultural system informed by science and scientific technology.

The seemingly devastating evidence against altruism pictured in Campbell's quotation from the zoologist Michael Ghiselin is, in my view, valid information which cannot be avoided except by those whose understanding is limited or confused.[13] Since religious belief is motivational for personal and social salvation only when it is believed to be true and carried out in deed, a confused and incredible understanding could not generate adequately strong religious convictions in a population that was persuaded of the validity of any seemingly controverting scientific pictures. Like Campbell, I do not fear the "hard" truth that has scientific validation, and I make more sense of the traditional religious wisdom in this light than in the sentimental, anthropocentric, subjective, wish-fulfilling dogma of some recent liberal humanism and social theory. Therefore, I count it as gain rather than loss to concur largely with Williams's picture of the hard genetic rule that the natural selection of competing alleles cannot produce within a species social altruism that extends significantly beyond close relatives.

Actually, my solution to the perplexing puzzle of how to explain human sociality within established scientific concepts takes its cue from Williams. His *Adaptation and Natural Selection* already pointed

out that the genetically evolved brain is a necessary part of the explanation.[14] He also pointed out that the general solution is akin to that of the adaptation of any species to an environment, that is, to an ecosystem which includes other species that may offer support as well as competition. In fact, it is to account for such adaptations to an environment that genetic and evolutionary theory has developed.

While Williams, on genetic grounds, asserted "that group-related adaptations do not, in fact, exist," he did not overlook the fact that there are complex human societies, and he specifically pointed out that man was an "apparent exception to the rule that the natural selection of individuals cannot produce group-related adaptations. This exception may be found in animals that live in stable social groups and have the intelligence and other mental qualities necessary to form a system of personal friendships and animosities that transcend the limits of family relationship. . . . Primitive man lived in a world in which stable interactions of personalities were very much a part of his ecological environment. He had to adjust to this set of ecological factors as well as to any other."[15]

While Williams gives a few suggestions on how a human brain could recognize friends and the possibility of reciprocal benefits whereby one distant cousin might be induced to repay help received from another in time of trouble, his *Adaptation and Natural Selection* hardly mentions how in a population of brains the information about and motivation for these mutually beneficial behaviors are selected and transmitted in human social evolution, except in a brief passage saying "this one ape . . . was transferred by evolution [of his enlarged brain, manual dexterity, etc.] from an ordinary animal, with an ordinary existence, to a cultural chain reaction."[16] The cultural chain reaction is now what we need to explain in more detail. But we must explain it always in the context of a population of individual animals whose basic values or norms for behaving are encoded in their genes and whose social values—no matter how highly civilized—statistically can never be programmed against what their genetic heritage requires, namely, survival of the genetic line. For, without a gene pool that can develop a phenotype with human capacities, there would be no human culture whatever.

Wilson's *Sociobiology* gives a wealth of detail on the evolution of sociality that is not given by Williams, and *Sociobiology* is a "must" reference for all who would work on social behavior, including morals and religion. But the basic theoretical problem that runs through Wilson's work is the problem which Campbell faced in his paper and which was so cogently expressed by Williams: How could genetic competition ever result in cooperation? *Sociobiology* provides a highly

informed development of some of the basic elements and possible solutions to this problem, such as those suggested by Williams above and some of those that have been developed in this and other issues of *Zygon* and other places. Probably nowhere has there been such a concentrated and comprehensive treatment especially of the biological factors as in *Sociobiology,* a primer for a burgeoning, new field.

A process to explain aspects of human sociocultural evolution in the context of the established genetic factors has been roughly outlined from varied perspectives by Campbell, F. T. Cloak, Edward C. Uliassi, and Robert Boyd and Peter J. Richerson in this issue of *Zygon.* But the addition of information on the evolution of the brain and its operation as simultaneously the seat of the genetically and the socioculturally transmitted values, I believe, will extend the explanation of how it is that civilized man could evolve under natural selection and why it is that natural selection is, as I previously have suggested, an excellent, modern symbol for man's creator and judge at all levels of his existence in which his animal nature is united with his higher nature.[17]

If we agree that genetics alone cannot produce large urban societies within a species except among individuals with identical genotypes as in the colonial coelenterata or individuals of very close kin (or otherwise on the basis of genetically noncompeting sterile castes within a close-kin population) as in the social insects, how is it that *Homo sapiens* did succeed in developing societies that spread far beyond the primitive, close-kin tribal societies of our ancestors? How does it happen that empirically we find socially cooperative and self-denying behavior, sometimes even the voluntary self-sacrifice on the part of many of the finest specimens for the sake of a complex group of many thousands or even millions of other individuals most of whom are not as closely related as tenth cousins, to say nothing of being as close as brothers?

Two factors have to be involved. First is insurance that the genetic line that produces such behavior is not eliminated in competition. This is tantamount to agreeing with Ghiselin and Williams that there cannot be any altruism or self-sacrifice of the real core or seed that transmits our nature from one generation to another, and I do this gladly since it fits some facts of evolved religion which I shall mention later. Meanwhile, as Campbell and others have noted above, the possibility for cooperating and yet benefiting one's genetic line is provided in what is called reciprocal altruism, a notion that has been developed by Robert L. Trivers but to which Williams pointed in 1966: Since, with his brain's elaborated capacities, man "recognizes his benefactor and remembers the help provided, [he] will probably reciprocate some day. A number of people, including Darwin, have recog-

nized the importance of this factor in human evolution. Darwin speaks of it as the 'lowly motive' of helping others in the hope of future repayment. I see no reason why a conscious motive need be involved. It is necessary that help provided to others be occasionally reciprocated if it is to be favored by natural selection. It is not necessary that either the giver or the receiver be aware of this."[18]

Williams seems a bit ambiguous here as to whether he is talking of natural selection of genes or of cultural patterns. Campbell, Wilson, and others clearly have posited the natural selection of a cultural pattern that is independent of or at least not specified by the gene pool. Certainly, the specificities of different human languages, technologies, and religions are not structured by genes. Certainly, these cultural patterns evolve and seem to be selected at the unconscious levels posited by both Williams and authors in this issue of *Zygon*. But Williams does not specify or even allow for the existence of or the mechanisms for the selection of sociocultural patterns independently of the genetic patterns.

This mechanism for sociocultural inheritance is the second factor that I suggest must be involved to account for the evolution of man's sociocultural patterns of social cooperation in specialized roles with conspecifics with whom he is not closely genetically related. It is at this point that the writers in this issue are going beyond Williams and the "central dogma" of the new DNA genetics, even though basically agreeing with them concerning the underlying mechanisms. Only in recent millennia have human sociocultural systems expanded appreciably beyond kinfolk tribes to draw together in cities reciprocally cooperating populations ranging from thousands to now millions, representing samples of species-wide distributions of genetic types. Because an essentially complete sociocultural transformation can take place within a generation, it cannot, simply because the change is so rapid, be explained on the basis of genetic information. But the important problem is that it cannot be explained genetically in principle and requires something of a "miracle" to show how the gene-selecting mechanisms that prohibit enhancing a competing genetic line have seemed to be overcome.

Genetic Selection as Favoring Interspecific Cooperation in Ecological Communities

My contribution to explaining this starts with the acceptance of the orthodox pictures of neo-Darwinian and biochemical evolution but adds a hypothesis that has been stimulated by some other hard biological facts that have been provided in my discussions of these problems with Alfred E. Emerson over the past twenty-five years.[19] The model

for my hypothesis for the mechanism for sociocultural evolution as an independent system of memory (inheritance), of variation (both blind [unconscious] and perceived [consciously planned]), and of selection (whether blind or consciously planned) comes from the model of *symbiosis,* the mutual adaptation of different kinds (species) of creatures to provide by their mutual contributions a resulting ecosystem giving more viability to each of the component species than would be possessed by any one of them alone.

In this kind of evolutionary change the prohibition posed by gene competition against selection for social cooperation is bypassed as clearly as it is in the case of the social insects or family cooperation, but by very different mechanisms. In the social insects and close-kin selection there is a clear genetic gain rather than a competition when genes operate to program phenotypes that cooperate to extend a common genetic line. In some cases, bodily self-sacrifice for siblings may and does enhance that line. In symbiosis, however, two different species are involved. Their community of cooperative behavior does not arise directly from competition among the genes within any one of the species. Instead, each species is separated from allelic competition by the fact of being genetically isolated from the other species. It also is isolated from interspecific competition by being in a different ecological niche. This opens up the potential for the genes within each of the separate species to compete exactly toward an improved interspecific adaptation as a more effective cooperating agent in an interspecific ecosystem. Here the cooperative, specialized roles of each species may produce an ecosystem that is more efficient or adaptive for each of the several species involved than would be the case of any single species seeking to perform all the functions necessary for life in the physical habitat.

The case on which Emerson has provided great illumination is that of the mutual cooperation of species in an ecological community. While he has written much on this since, I quote a nice statement of the situation from his presidential address to the Ecological Society of America in 1941:

> . . . the social insect colony is an interspecific ecological community consisting of numerous species of plants and animals adjusted both parasitically and symbiotically to the internal environment of the supraorganism. [L. R.] Cleveland has shown that the wood-eating roach and termite communities were fundamentally functional adjustments promoting an efficient cooperation between the wood-eating insects and their symbiotic cellulose-digesting intestinal protozoa. In order that the molted individual could become reinfected with [the interdependent] protozoa, it was necessary for such an individual to

live in a family or social community. Thus evolution has resulted in an integrated, balanced, biological system incorporating organisms of various species and various organismic levels, in its entirety exhibiting dynamic equilibrium between its parts and with its external environment.[20]

Instructive for understanding interspecific cooperation approaching complete interdependence and cooperation is the case of the social termites, which emerged from family systems of primitive roaches to find a more viable ecological niche in symbiosis with species of flagellate protozoa. The flagellates flourished better in the more protected environment, and an effective supply of their food was found by inhabiting the digestive tract of the wood-eating termite. The protozoa could metabolize wood cellulose to provide more than enough sugars for themselves. The surplus product enabled their termite host to be nourished by the wood—a plenteous source of food. The symbiosis of these two very different species is an adaptation, accomplished by the gene pool of each species separately, but in relation to a common external environment, an adaptation to an ecosystem in which mutually beneficial functions with other species are not only possible but common.

This adaptation of two independent species into a common system that embraces both of them (and also other species), a system that may make each species completely dependent upon and "devoted to" the needs of the other, as in the case of termites and their flagellates, is a symbiotic reciprocal cooperation. The mutuality of advantages for the respective species—given by the new ecological niches into which their symbiosis allows them to move—has been selected and recorded in DNA codons by the same system of natural selection of genes that selects all living systems. Williams calls such symbiotic evolution within an ecosystem a "biotic *evolution,*" as distinguished from "organic evolution." Since the information that structures or provides the patterns of such mutually beneficial relations among the various biological species within the preliving physical environment of a habitat seems to be found only within the gene pools of the several adapted species, Williams does not want to call this "biotic *adaptation.*"[21]

However, this refusal to call a viable ecosystem "adaptive" seems to be a misleading restriction on the term "adaptation" that arbitrarily cuts off from genetic theory the operation of interspecific coadaptation which one would suppose geneticists would be as proud to proclaim as they are the very effective explanatory model of intraspecific or intragenomic *coadaptation.*

The indirect (secondary) epistatic effects of multiple interacting forces in a genotype generate outcomes that are different from the

mere sum of the direct effects of each of the individual forces. Since selection operates on the total system of forces interacting, the result tends to be the selection of the coadaptedness of the multiple genic sources whose interaction generates living systems. Emergent adaptive traits of whole systems, whether intraspecific or interspecific, occur. This requires that one read the presence of the several gene pools of the several interacting species in a common habitat as a system of coadapted information units that collectively operate as the integrated unit that, in fact, does structure the ecosystem and its adaptation. To be sure, the integrated information generating the symbiotic group is selected by, and only by, the survival of the particular genes that remain in the competition carried on within some particular species, as Williams insists it must be. There is no conflict here.

But, if we take into account the fact that a particular species functionally is coadapted with other species in a symbiotic community of an ecosystem, then that information which instructs the biota is also selected and stored in the collectivity of the gene pools of the several interdependent species. The coadapted selection of these several information banks is a program that promotes the success of the biota as well as that of the organisms of the different species that constitute it, insofar as the organisms of the different species, in fact, do constitute a reciprocally functioning or interdependent net in an ecosystem.

The selection of a biota is not "group selection" within a species from competing genes. I am perhaps more convinced than Williams that it is "tautologically" as well as factually impossible for genes to be selected that confer an advantage on their competitors. But Williams points to the fact that it is quite clear that competition among alleles (different forms of the same gene) in a population is exactly what produces that population's adaptation to its environment, to an optimal role in an ecosystem consisting of other functioning species as well as of certain physical characteristics. In those cases where mutual adaptations of a *group* of species that cooperate to constitute an ecosystem do provide greater viability for the several species than is otherwise possible, the interspecific collectivity of coadapted genes is a *biotic adaptation* just as clearly as the intragenotypic collectivity of coadapted genes of any particular organism is an *organic adaptation,* even though the former could not occur apart from the latter.

Nongenetic Information in Evolution

Because the informing mechanisms or boundary conditions that shape the flow patterns of energy and materials that we know as life are in the last analysis more than those contained in the genes, and

since a larger picture helps us to understand our place in the scheme of things, I wish at this juncture to point out some of the new perspective on evolution that goes beyond that of many of the neo-Darwinians. A number of scientists have approached the problem of life systems with a more physicalistic and information-science view, within which genetic fitness naturally falls as a subclass. The larger picture presents living systems in terms of the physics of metastable patterns in thermodynamic flows. The cybernetic guidance provided by the genetic code over the behavior of other molecules in a cell *is only one of many mechanisms* that exist in nature to provide metastable states far from thermodynamic equilibrium, although it is clearly a primary kind of document for life on earth.[22]

Among nonliving cybernetic mechanisms, for instance, is the water cycle of the earth, which returns ocean water as rain to the highlands and keeps our rivers flowing and fills our lakes. Such general, steady-state-maintaining mechanisms, which natural forces determine or select, existed long before they evolved to such higher levels as the DNA controls for the dynamic flows of matter energy in organisms. The norms, boundary conditions, or controls of the stable patterns of preliving flows, such as rivers and lakes, not only are selected but evolve with changing environmental conditions, as when mountains are lifted and valleys deepen. Much evidence has been accumulated to show how energy flow patterns characterize all dynamic systems from prebiological to the most refined operations of the human mind and sociocultural system. An interesting and graphic view of some common principles of energy-matter flow in the broad range from solar energy to complex human societies, including religions, has been presented by Howard T. Odum in his *Environment, Power, and Society.*[23]

The same general system of physical nature is involved in the accounts by the molecular biologists of the various interactions of DNA and its environment to produce the characteristic activities of the living cell. And as Bronowski puts it: "There are evolutionary processes in nature which do not demand the intervention of selective forces [in the limited or neo-Darwinian sense]. Characteristic is the evolution of the chemical elements. . . . Here then is a physical model which shows how simple units come together to make more complex configurations; how these configurations, if they are stable, serve as units to make higher configurations. . . . The sequence of building up stratified stability is also clear in living forms. Atoms build the four base molecules [that] are built into the nucleic acids, which are remarkably stable in their turn. And the genes are stable structures formed from the nucleic acids, and so on . . . to the complete cell."[24]

For a larger picture of the truth about human life, not only do we

need to go to the *pre*biological, underlying physical circumstances and laws which have created the stable dynamic systems found there —such as the lakes for habitats or the stereochemical structures for genotypes and phenotypes—but also we must look into the operations that are going on at levels that more recently have emerged than the DNA codes to structure our behavior.

Living organisms are, much more than we have previously acknowledged, dependent for life-sustaining behavior upon information that is not in the chromosomes. Of course, there have long been a number of biologists who have kept to the fore the importance of cytoplasmic agencies of inheritance. There have been interesting hypotheses with supporting evidence for understanding the eucaryotic cell as a symbiosis of formerly independent and separate lines of evolving systems, some of them carrying nucleic acid information independent of the chromosomes. Neither does one know how much non-nucleic-acid information there may be within a cell, including the genetic repressors and metabolic controls constructed of amino acids. Many have questioned the possibility that even the tremendous amount of information carried in the genes could be capable of specifying the stupendous amount of information that cells and organisms obviously possess. The epigenetic differentiation of the special cell types in multicellular organisms certainly requires information not found in the genotype. Howard H. Pattee and associates in *Hierarchy Theory* have presented a promising analysis of how to understand the problem of the organized complexity of living systems. Their view suggests that the maintenance and development of the organized complexity of living systems do not lie in any one level, such as the genotypic description, but come from an interacting hierarchy of levels of structural and descriptive systems. One of the associates, Herbert A. Simon, had earlier written that an organism, even a man, "as a behaving system is quite simple. The apparent complexity of its behavior over time is largely a reflection of the complexity of the environment in which it finds itself." Let us now turn to examine a special element of the environment in which man finds himself, a feature we must understand if we are to understand how genetic restrictions on cooperative social behavior with non-closely related conspecifics have been transcended significantly for the first time.[25]

Not only is the physical or organic environmental ecosystem of an organism full of "information" with which genetic information interacts and becomes coadapted, but there is a special division of man's environment which is structured by "culture" in the anthropologic sense of that term. Human culture is so packed with necessary infor-

mation for life that the gene pool of *Homo* must have become inviable apart from it at least as far back as when we became dependent on the social transmission of hunting-and-gathering lore and technologies. Our underlying genetic library of information for living—which is selected from, stored in, and transmitted through genotypes within the genetic information pool of the species—obviously has been *fit* in the temporal dimension (the primary biological meaning of "fit") to keep us adapted or persisting in being over a very long time. It is also *fit* in the dimension of environmental range and complexity to enlarge the range and complexity of ecological niches we could occupy during the past thousand million years. But our fitness in both these dimensions, especially the latter, has been enhanced increasingly in the past one million years by our new cultural library of information for living—which is selected from, stored in, and transmitted through brains (often aided by brain-created artifacts external to our organisms, including books) in the cultural information pool of our species. The cultural information has become increasingly essential for the life of our species as this information has adapted us increasingly to ecological niches to which we are not and even could not be adapted by genetic information alone, even if the rate of genetic selection could be increased more than a thousandfold to catch up with the rate of cultural selection.

Cultural "information" indeed is stored in the brains of the population at the points where the genetic and the novel neurological memory of somatic learning overlap. The human brain is the integrating mechanism within which three levels of nature are coadapted to produce human nature. I presented in 1951 to an early meeting of the Society for the Scientific Study of Religion this trinity of the information that shapes human behavior. The trinity consists of (1) the physical elements of our environment, (2) the genotype, and (3) the culturetype.[26] It seemed to me then that the empirical data for understanding human nature in its deeper dimensions required an understanding of the presence of and relation among these three very different but interacting levels of our nature and required that we recognize the temporal and causal sequence or emergence of these three levels of structures in our development.

The relation between the human gene pool and the prehuman habitat—and the reciprocity of the two systems of information—at that time already was beginning to become clear from the neo-Darwinian evolutionary pictures presented by such as Julian Huxley and George Gaylord Simpson, although the term "information" in its new scientific meanings was not yet being used. We are presently at a similar or perhaps somewhat earlier stage in our understanding of

the joint or reciprocal interactions between the culturetype and the other two systems. As recently as 1961, anthropologists generally shunned notions of cultural evolution and particularly the notion of any transhuman natural selection (genetic or nongenetic) operating in it. The proposals from outside the social sciences by men like Huxley, Simpson, and Theodosius Dobzhansky have been a powerful influence in opening our intellectual horizons to the interaction between these levels.[27]

The Societal Organism as a New "Creature" with Which Sapiens Is Symbiotic

With the enlarged view of human evolution presented above, we can continue with our picture of the mechanism by which genetically selfish humans become social cooperators by a symbiotic adaptation to a new creature, the *societal organism,* that has relatively recently emerged in the evolution of genetic man's ecological niche.

While the thrust of *Homo sapiens* into an entirely unprecedented success as a social animal has been noted clearly by Campbell and others in this issue of *Zygon*, as well as by Wilson in his *Sociobiology* and many others,[28] I do not find that anyone has yet provided an adequate explanation of how human evolution overcame the prohibition of cooperation between competing genetic lines so clearly presented by Williams and others and generally acknowledged in biology. The hypothesis that I advance is that this prohibition has been transcended specifically by *Homo*'s adaptation in symbiosis with what is tantamount to a new kind of living creature in its environment. Humanity is not a single species but a new kind of symbiotic community. While there are many other biologicial species, such as grains and cattle, in the human ecological community, these are of secondary significance for human society and would not make human society significantly different in character from insect societies. The significant symbiosis of *Homo* is with a new creature such as the earth had never seen before, a creature that is only partly biological, only partly programmed by genetic information. In this symbiosis between biological men and sociocultural systems, men are in a sense analogous to the species of flagellate protozoa that became symbiotically adapted to serve a function in the intestine of termites in return for reciprocal advantages. But the new being or "creature" within which men are symbiotic is a societal organism, the critically significant elements of whose being are not only not programmed by anything in the human gene pool but not programmed by any gene pool whatsoever. The evolution of culture is postgenetic or a new kind of

epigenetic information produced by the nongenetic selection of brain patterns.

The two systems of this symbiosis, men and sociocultural organisms, are as intertwined and interdependent in their operations as are some of the paired but basically independent and originally separate elements that constitute the dynamic interactions that we call biological systems—such as the chromosomal nucleus and the cytoplasmic DNA of the mitochondria of a cell or as the metazoan zygote and the epigenetic information source that interacts with it to differentiate the successive generations of the zygote to form a complex organism—so that the semi-independence and distinction in the heredity-transmission processes are difficult to untangle. But to understand human social cooperation it is necessary to disentangle them and to show that the societal organism is indeed an independent living creature to which biological man is symbiotically adapted to constitute humanity. I shall seek to show the *independence* of animal man and sociocultural system and the *living* character of the latter as the newly emergent symbiotic partner of organic man; but first I want to emphasize humanity as the name of the symbiotic community. Emerson early called his symbiotic termite communities supraorganisms—those complex, coadapted, cooperating communities of species that function together in the ecosystems associated with termite nests in a coordinate way as in an organism.

Wilson's *Sociobiology* presents a good account of what biologists have called superorganisms in his account (in chaps. 18 and 19) of the first of four pinnacles of social evolution: the colonial invertebrates (including the corals, the jellyfish-like siphonophores, and others). Wilson has pointed out that this first peak in social evolution was the most successful in terms of cohesiveness, altruism, and cooperativeness —except possibly for the fourth pinnacle, which is human society. According to Wilson, the possibilities of social cooperation appear to diminish as the unit organisms get more elaborate, as we see in his evolutionary sequence of the first three pinnacles running from (1) the remarkably organism-like zooids of the primitive colonial invertebrates (that can make up such a complex, organism-like structure as the Portuguese man-of-war), where each colony starts from a single zygote and hence possesses a genetic relation of 1; through (2) the societies made up of such complex individuals as the ants or termites, where the genetic relation is commonly ½ to ¾; to (3) the weakly social mammals, such as lions or monkeys, where the genetic relation among siblings cannot average more than ½ and where decreasing relation seems to mean decreasing degrees of cooperation. The social

bonds and specialization of functions are so weak in mammals prior to man that there is little tendency to see any resemblance to a superorganism as there was in the siphonophores. I emphasize that the decreasing degree of cooperation in this series of three stages parallels the decrease in their genetic relatedness.

I call attention to the fact, important for solving our problem, that in the evolution of life prior to, developing along with, and fundamental for all these four pinnacles there were two other stages essential for social bonding and cooperative behavior.

One stage was the metazoon or the true organism—a society composed of many cells, such as is the case for all higher species of plant and animal organisms. Here, overcoming the genetic prohibition of even self-sacrificial cooperation was possible because all the cells of the organism were and are programmed in fact by identical genotypes—added to which the overwhelming majority of the population of cells in an organism are genetically sterile and not, therefore, in competition. Even though the metazoa achieved extremely loyal services and unhesitating altruistic self-sacrifice of cells on behalf of the well-being of their social organism, they also maintained the genetic variability—necessary for continued evolution by selection —in a specially segregated operation for the propagation of their species. This is a dual wisdom to be kept in mind by human social planners of cultural patterns. The segregation of the function of transmitting the varied genetic potentialities is related to the other stage.

The other stage was the emergence of sex, of bisexual reproduction, which required the cooperation of a male and a female organism each significantly genetically different from the other. In this adaptation, natural selection found a way to elicit at least a temporary cooperative act, copulation, from two creatures whose genetic blueprints indeed were competing within the same species. It was highly adaptive (for any species possessed of sufficient diversity in its gene pool that had already been tested as reasonably viable) in providing useful genetic variation for more readily meeting changing environmental contingencies at a much reduced cost as compared with producing variability by mutation. Providing variability by sexual recombination was possible because of the emergence earlier of the dual strands of genetic information for maintaining life systems, a dual strand necessitated by somatic death and genetic reproduction.

From primitive sexuality emerged what we know in mammalian and human life as the family. From the highly adaptive virtues of sexual recombination of genes there would naturally be strong selection for powerful mechanisms to insure mating regardless of obstacles

of any kind, including those inherent in genetics. The powerful sex bond between parents and the mutual kinship bonds to and among their offspring provide explanation for the motivation of high levels of cooperation and even self-sacrifice in families. From the combination of the powerful sex bonds and close-kin ties of families and extended families there emerged the possibility of motivation for social cooperation among creatures with moderately diverse genotypes. Sexual and kinship bonds are probably essential pillars of human society. I believe we now can begin to explain how and why the often unnatural and unwanted (so far as instinctive motivations are concerned) taboos or restraints concerning sexual behavior in human society were selected in cultural evolution as good or desirable and have been reinforced by rituals, myths, and more direct social constraints: simply because sex privileges and kinship bonds are of the essence in shaping the motivations for social cooperation. The family and sexual bond and related strategies are a foundation on which the fourth and most unique and successful of Wilson's pinnacles of social evolution—human society—was erected at the motivational level.

Human society is the first vertebrate society significantly larger than sexual partners and offspring where conspecific organisms of widely diverse genotypes have become socially organized into anything like the complexity of interdependent, organic functioning that excels that of the social insects and in some ways even that of the colonial invertebrates. The colonial invertebrates were all colonies where each cell had the same genetic blueprint, except for possibly a very interesting case, that H. Oka reports finding in one of the tunicate colonies, with a "recognition gene" which, acting analogously to the mechanism for sexual recombination, permits two colonies to combine without the usual rejection and necrosis responses that usually prohibit cooperation between cells or organisms with different genotypes.[29] Human societies have extended cooperative motivation generally to include genetically diverse conspecifics by means of neurologically mediated cultural "recognition genes," a sociocultural mechanism analogous to the biogenetic mechanisms that have shaped bisexual reproduction and the family.

But the new evolutionary emergent in mankind is an even more radical one than the emergence of sex and the family into kin-group societies. This should be clear from the fact that within populations whose genes are competing there is little or no evidence of elaborate social organization approaching that of an "organism" or "supraorganism" beyond the bounds of close family ties until man arrived.

Central for an effective theory or explanation of the emergence and continued existence of stable, cooperatively functioning com-

munities of conspecific organisms, most of whose alternative genetic forms are competing under natural selection, is a demonstration that the whole population indeed is patterned genetically to be adapted symbiotically to a common, external, or extraspecific living creature. And even here the symbiosis must provide advantages for continuation of a genetic line that are greater than the advantages conferred by competition with conspecific organisms. (I shall leave to another place the problem and solution of *Homo*'s need for continued genetic competition.)

My hypothesis—that human sociocultural systems are indeed such external or independent living creatures, truly societal "organisms"—might imply that I am following a tradition advanced by such men as Auguste Comte and Herbert Spencer. But my concept arose in fact from a different direction and has the advantage of being formulated in the light of the contemporary understandings of evolutionary mechanisms that I outlined above. We are forced to develop some such hypothesis by the conjunction of such clear evidence as Williams presents for the nonselection of altruism by competing alleles, combined with the clear evidence that in man the empirical fact is we do have a unique case of non-kin societies with high degrees of cooperation. Moreover, the new extensions of evolutionary theory now allow a credible hypothesis. Campbell's suggestions on how this fits in with facts of sociocultural evolution and how religions have provided the motivating mechanisms for overcoming our genetically programmed selfishness have augmented, by developing further, some similar hypotheses that I have been contemplating for some years.

The primary problem is to show how a body of life-shaping information is established and transmitted independently of the human gene pool and how it shapes a behaving or living system in ways unspecified by the human gene pool but instead has evolved or been selected as symbiotically adapted to populations of wide ranges of human phenotypes and their correlated genotypes. This is not difficult in the light of recent biological theory and data.

The Independence of Societal Organisms from Particular Populations of Homo

One should note that the "societal organisms" with which populations of *Homo* have become symbiotic are not among any species of the plant and animal kingdoms. To be sure, man lives in interdependent symbiosis with such creatures as cows or pigs and wheat or corn, just as the flagellates live in symbiosis with the termite. All the prehuman species in such an ecological community are programmed for such

cooperative or mutual functioning by genotypes dealt out more or less randomly from the gene pools of the respective species, and those that are adapted are selected. The same is true for the elaborate societies of insects within their elaborate ecological communities of interdependent flora and fauna. But the human societal organism is programmed only partially by the human gene pool. It is a creature in whose evolution its informational sources, although highly specific, have become increasingly nongenic or epigenetic and not specified by the DNA of the chromosomes. Its phenotype or body is, of course, a population of human bodies of diverse genetic heritages, together with various culture-specific societal artifacts. The societal organisms, like Emerson's supraorganisms, also include in their "somata" a number of nonhuman organisms, including those found on farms. Such societal organisms are structured by the combined information transmitted as culture and the genetic information carried in the gene pools of all the symbiotic plants and animals as well as the diversified genotypes of *Homo.*

I have followed Williams, Wilson, and others in specifying that the societal organism is made possible only by the evolution of a complex brain. The new "gonad" or information storehouse for the phylogeny of the societal organism is the collectivity of somatic cells found in a population of human brains. This collectivity has the capacity to receive and transmit symbols that are determinative of behavior of a changing population of brains. To a remarkable degree it is independent of what particular sampling of the human gene pool provides the basic structures of those brains. This possibility has emerged in the coadaptation of the social organism in symbiosis with *H. sapiens. Sapiens'* brains were selected genetically by the circumstances of evolving symbiosis in an environment created by the societal organism so as to provide the complex powers for understanding and communicating the possibilities of adaptive advantages for each individual *sapiens* in return for his symbiotic services to the societal organism.

One of the essential coadaptations of the human gene pool was the loose coupling already referred to above between the reptilian level of the human brain (with its tightly genetically controlled response patterns) and the new outer cortex (with its capacities for receiving, remembering, and transmitting the heritage of a societal organism). As already pointed out, the societal organism in fact has no other "gonad" than the human brain, even though much of its culturetype (the analogue of the genotype) and consequently much of the phenotype lie outside the biological organisms of *Homo* in all kinds of artifacts—such as tools, hearths, pots, gardens, houses, shrines, tablets, cities, maps, ships, books, blueprints, buggies, roads, factories, met-

ropolitan complexes—to which the symbiont *sapiens* swarm both to service and to utilize. But, without a living brain produced by the gene pool of *Homo*, no ritual traditions, myths, or printed books are generated, communicated, and responded to. One exception is some recently emerged artifacts, the computer-operated cybernetic systems—primitive, new, almost living creatures that possibly may become symbiotic with *Homo* and his symbiotic societal organism and eventually replace both of them.[30]

The specimens of Humanity—societal organisms in symbiosis with biological organisms—are huge, supraorganismic "phenotypes," consisting of a population of genetically diverse individual human phenotypes, many nonhuman species, and include an elaborate, extrasomatic, artifactual apparatus. I shall be inclined to use the single creature, the "societal organism," to denote the symbiotic union of societal organism and the population of *sapiens* that constitutes the local ecosystemic supraorganic phenotype of Humanity, just as for biologists the much larger and visible "termite" is used to denote a similar symbiosis of one very large individual of one species with many thousands of the tiny individuals of the symbiotic species inside it, even though a proper analysis requires recognition of the two genetically independent species whose symbiosis generates the "phenotype."

The bonds that bind the genetically diverse ape-men with the supraorganism are the neurologically transmitted promises of greater benefits from symbiosis with a societal organism whose life is long and faithful compared to men. Some of them have a continuity of thousands of years, as in Egypt. Like biological organisms, societal organisms are composed of parts or "organs" such as a language or an agricultural, mining, manufacturing, or transportational technology. Unlike biological organisms, because of the Lamarckian heredity mechanisms of brains, these parts are more readily transplantable from one societal organism to another and are known to persist as transplants in evolving continuity for thousands of years. Societal organisms are thus modifiable and can evolve, in Lamarckian fashion without death, by recombinations of information in a multitude of ways. In a 1960 discussion of how the societal organism evolved Henry Alexander Murray in puckish analogy with "gene" suggested it would be by mutations of "idenes."[31]

The Independence and Coadaptation of the Genotypic and Culturetypic Heritages of Humanity

The viability of a societal organism depends upon its own transmission of the essential information to structure the behavior of the symbiotic collectivity in such ways that reciprocal gains indeed are

experienced by the participating individuals. The selection of the *Homo*–societal organism symbiosis is a two-way adaptation, as in the case of the coadapted genetic pools of flagellates and termites. But in the case of the societal organism there is only a partial genotype or gene pool for its own distinctive attributes, in contrast with the full genotype in the termite. This partial genetic structure is, of course, some segment of the human gene pool that produces the varied phenotypes that constitute the societal organism. Societal organisms are, as we well know, "parasites" on human individuals, just as human individuals are mutually parasitic upon their societal organisms. The great variety of the individual human phenotypes and corresponding genotypes within the societal organism is a part of the design that makes human societies so much richer than insect societies and supraorganisms. But, as we have seen, because such human populations cannot become organically or cooperatively organized by the genetic source, a special, epigenetic source of information has emerged. This portion of the generating information of the societal organism is its culturetype. This information is stored in the brains and correlated artifacts of the collectivity of the diverse phenotypes of *H. sapiens* constituting a societal organism.

In each case, the information structuring each type or "species" of societal organism, which I have called "culturetype" more commonly than "idenotype" (and hence I was interested just recently to learn that Boyd and Richerson independently have used the same term),[32] has to be adapted to each *sapiens* phenotype and hence is selected by (or made "fit" with respect to) the particularity of each *sapiens* genotype on the average (no matter how varied they may be) within the human population embraced by the societal organism.

It is commonly observable that, when this adaptation does not take place, either the unfit societal organism or a number of its unfit individual persons are "selected out" by the nature of the situation. To some degree societal organisms can immunize themselves from destructive or cancerous deviants (whether the deviation is genetic or learned does not matter) by various systems of ostracism, ejection, immunization, or incarceration. But the very nature of symbiosis implies that, for the statistical average and indeed for the vast majority of any viable cases, the adaptation has been suitably engendered internally in the basic motivational mechanisms of each of the parties to the symbiosis.

The societal organism is as transcendent to all creatures in the biological kingdoms as those biological creatures are transcendent to the prebiological, chemical coacervate species in the tidal pools before there evolved the symbiosis of amino with nucleic acid polymers to con-

stitute a biological cell. In the past million years—or perhaps in only the past ten thousand years, as far as urban civilization is concerned—mankind has been witnessing and participating in an event that is without equal in the evolution of life since about a billion years ago. What has happened is the emergence in the human brain of a new memory system for phylogenetic information which is essentially independent of a particular gene pool and yet coadapted to it in a "symbiotic" relation of mutual benefits. John Kendrew pointed out:

> We may thus describe three different types of information that are of importance in biological systems: [1] the genetic information, which does not [during a lifetime] have feedback from the organisms but is passed on from generation to generation; [2] stored sense data [in the brain], which do have considerable feedback into the storage system of the organisms but are not passed down [like the genes] from generation to generation; and finally [3] communicated data, which do have feedback and are also passed down to the next generation. It is the possession of the third kind of information in large amounts that makes *Homo sapiens* unique as a species; . . .[33]

It is this cultural information that informs, shapes, or structures the human societal organism as a totality and does this independently (beyond a certain point) of most of the details of the genetic base of information that shapes the characteristics of the societal organism's constituent human individuals. Julian Huxley sensed this. Man, this unique kind of animal, had crossed "a threshold to a new kind of phase of evolution, which may be called 'cultural' or 'human' or 'psychosocial.' " The late geneticist H. J. Muller had somewhat related views.[34] This does not mean that genetic evolution is over or no longer necessary. On the contrary, genetic selection is just as essential as ever it was, and it will need to become a part of our future ethics if we are to survive, as Muller emphasizes. In my hypothesis of symbiotic coadaptation of genetic and cultural information it is essential that our cultural wisdom "satisfy" the prior requirements inherent in the variety of genotypes that shape the phenotypes of the societal organism's human population. Insofar as a complex hierarchy of systems (such as a civilization or an ecosystem) have been coadapted to constitute a more or less integrated whole to perform a set of integrated functions in which the several subsystems are essential participants, it is logically inescapable then that no essential part, element, or species in the system can be hurt without hurting the whole. Hence in the societal organism there has to be a cybernetic control system to provide what Emerson has called "dynamic homeostasis."[35] Each part has to be kept in mutually optimal "symbiotic" adaptation to all other parts. Just as the symbiotic termite and flagellate species are mutually

adapted to make a viable or stable organic community and ecological niche, so the populations of the animal species *sapiens* and the various kinds of its symbiotic societal organisms must be adapted to each other. This point is of the essence. Neither one can be wholly independent or disregarding of the other, or the symbiosis will be harmed, just as is the case for the parties to any of the ecological symbioses.

It has been noted by anthropologists and historians that there are societies that have failed or have been eliminated. In some cases the errors were mismatches between the sociocultural information (culturetypes) and the variety of human genotypes in the gene pool. In other cases the errors were mismatches between the culturetypes of the societal organisms and the larger ecosystem, including other societal organisms. In some cases certain populations of phenotypes (and their further contribution to the gene pool) have been wiped out completely by starvation, disease, or war, thus changing the character of (selecting) the genetic and cultural pools of humanity. This is one mechanism by which Wilson's and Simpson's earlier suggestions for the continuing matching of the genetic with the sociocultural information to achieve a common viable phenotype may be carried out. One can say that the selection processes that simultaneously act upon the several sources of genetic and cultural information that combine to shape the symbiotic *sapiens* and the societal organism actually operate to coadapt the totality of information harbored and transmitted in each of these beings so as to be on the whole productive of the viability of this totality within the larger ecosystem of which it is a component.

One might note in passing a few of the advantages of the new symbiosis for rapid selection and evolution, as compared with the Mendelian genetic system by itself. As Wilson, Kendrew, and others have pointed out, the evolutionary rate of Mendelian populations requires at least a few generations, say of the order of ten, to make some small changes. For *Homo,* this means a few centuries at least. The new symbiosis of *Homo* with the societal organisms has allowed men in a few years to transcend by a millionfold the rate of the evolution of flight that took millions of years for such biological classes as Insecta and Aves. The evolution of aviation in the symbiotic *sapiens*–societal organism hardly has been going on for a century, and through it *Homo* has accomplished what no biological creature has or probably ever could do: fly to the moon. The new culturetypes can leap from brain to brain and transform persons and culturetypes in split seconds and do this almost simultaneously for the world population of billions via telecommunications systems, as when a war starts or a new medical benefit is discovered. But our main question is

exactly how the culturetype of a social organism binds a genetically diverse population into a highly cooperative, living whole or supraorganism.

The Coadaptation of Culturetypes with a Diverse Population of Human Genotypes: A Result of Religions

If we look into the locus of that portion of a societal organism's life-shaping information called culturetype, as we have noted, instead of being harbored in the gonads it is harbored in an organ at the other end of the spinal column of the vertebrate *Homo*. We also have noted that each individual brain is fed its basic and somewhat differing or unique values (goals) from its unique genotype, which programs the development of its structures and behavioral proclivities. We need to consider how the brain is at the same time the seat of the common culturetype. In optimally viable human societies my hypothesis would say that the culturetype is essentially identical (as are the genotypes of identical twins or of the cells of an organsim) within all the brains of a population constituting a societal organism. The two sources of information in the brain give man his "two natures" that so often are not wholly mutually adapted. To the extent that these two natures fail to be completely harmonious, we find the tension so familiar to religious tradition and lamented by Saint Paul who complained of this conflict in his celebrated confession: "For I know that nothing good lodges in me—in my unspiritual nature, I mean—for though the will to do good is there, the deed is not. The good which I want to do, I fail to do; but what I do is the wrong which is against my will; clearly it is no longer I who am the agent, but sin that has its lodging in me. . . . Miserable creature that I am, who is there to rescue me out of this body doomed to death?"

Fortunately, the harmony between a population of *sapiens* and a societal organism is not always at such a discouraging level. Perhaps in most brains the consciousness of a possible disharmony between the two natures does not become very acute because of a genetically inbuilt buffer. The total system is probably too complex and insufficiently explored for a scientifically valid analysis at the moment, but it is exactly such tensions or pressures to adapt—whether genetically or socioculturally—that provide individual men and societal organisms with their phenomenally high rates of evolving. At the same time, protective mechanisms against cognitive and aesthetic dissonances that are too radical and too disruptive have been evolved by both genes and cultures. We cannot do without the wretched religious prophets and artistic perceivers of sin and evil. The whole system for social or ethical motivation of individual persons requires there to be

in societal organisms the information necessary for their being adapted to the requirements of the wide diversity of the genotypes of individuals in the population on the one side and to the requirements of the larger ecosystem on the other.

A central societal agent in accomplishing this has been religion. Beginning as much as one hundred thousand years ago, according to estimates published by Dobzhansky and Anthony F. C. Wallace, religions evolved to meet these several sets of ultimate requirements as the central value core of the societal organisms. They have become intricately adapted to the wide spectrum of human genotypes (and hence phenotypes) out of which each society is itself constituted and also adapted to the total ecological community that is the niche of the societal organism. I shall summarize a few main points on which I and others have written more fully elsewhere.

Within any viable or adapted specimen of a societal organism, religions have been relatively coherent systems of information, transferred from brain to brain by ritual, myth, and theology (three successive levels of culturetypes or idenes). Because they have presented a common system of meaning communicated by ritual and myth of a particular tribal population symbolizing loyalty to common ancestors (family kinship) and to various common rights and duties enculturated from impressionable infancy and childhood on up to death, religions in culturetypes have functioned analogously to the common genotype that bonds the members of the primitive organic societies such as the social insects. As the number of families and the genetic range of the tribes and tribal associations increased, the rituals and myths came to celebrate ancestors and gods sufficiently remote and sovereign over all to maintain the family image and loyalties. In some cases at least, there were stories to celebrate the partial extension of the loyalty to more distantly related families through marriage. While such images could not provide the actual close genetic bonds such as those in the social insects, they could provide the equivalent benefit for all the genetic lines cooperating within ever larger tribal groups in what we may call "virtual" or "spiritual" brotherhood. This benefit came by virtue of any stray or alien person's symbiotic affiliation with one particular societal organism through a voluntary acceptance of its culturetype. This provided the common bonds that would insure a statistically better chance for the genetic line of any faithful adherent than would nonaffiliation. The reciprocal favors or cooperation within the societal organism insured this for individual man as did the protection of the termite's gut insure the viability of the symbiotic flagellates. At the basic level of analysis, Marx and Freud were wrong in debunking religions as false myths. While Freud was a pioneer in

unveiling some aspects of myths, he presumably was not aware of what we now know concerning the prohibition of cooperation beyond the family by genetic mechanisms or the essential validity of the religious myths for transcending this.

The information which the religious segment of the culturetype transmits provides the cybernetic norms for the societal organism, shaping the roles and loyalties of all the adhering population (no matter how genetically diversified they became in some cases) to function in the service of the societal organism with the same efficacy as the flagellates serve the needs of the termite. But it should be noted that my hypothesis does not grant to humans the same degree of somatic self-sacrifice for the societal organisms that are possible for the social insects and individuals in the colonial microorganisms. There is nothing in the human situation that makes possible continued genetic fitness when the individual organism is sacrificed before giving rise to offspring. While in very close relatives, such as in the three-quarter to unity relationships found in social insects and colonial microorganisms, there can be sacrifice of somata while enhancing genetic fitness, this is not even theoretically possible in vertebrates. Hence the societal organism must be so programmed or informed that it actually does provide fitness, statistically at least, to each of the individual humans it admits to its organism. Hence religions have evolved to transmit values and motivations in their adhering populations that effectively result in the implied, long-term salvation of the soul beyond the death of the body. The soul, as I have written in other papers, includes the genetic information which does possess indeed the kind of immortality that religions long have proclaimed. I should note also that by "soul" I do not refer to the peculiar myths or theologies of any particular religion but to whatever may be translated scientifically as their analogue or equivalent for the continuity of life and true being, such as the karma-nirvana doctrines in Eastern religions.

Because the product of religious enculturation and the resulting societal behavior patterns does result in greater fitness statistically to the individuals involved, one could say that religions serve as "immunizing" agents for the body politic against the potential virulence of the inherently competing and hence alien genetic patterns within it. Except for close kin, each individual is competing genetically with the others within the society. Without any agency which provides the brain with information to neutralize or "immunize" the usual consequences of these genetic differences and to motivate the proper service roles, we could not have our unique kinds of societal organisms. Religions in fact must guarantee an effective coadaptation of the di-

verse individuals with the societal organism so as to produce at least as good a chance for the continuation of each individual's genetic line as would going it separately in some primitive primate kinship groups.

Religion and religious information in the form of rituals, myths, and theologies have been selected themselves in the evolution of our genotypes and culturetypes. Their evolution yields a "phylogenetic" sequence. Genetically programmed biological rituals originated perhaps more than a hundred million years ago. Culturally transmitted ritual patterns are evident in avian and mammalian species, indicating that these may have arisen in our ancestry at least ten million years ago. Oral myths tied to these rituals (which have been found by anthropologists in primitive societies rather generally) could not have arisen until the human brain had evolved the capacity for linguistic communication, which would date them not earlier than a few hundred thousand years ago. Consciously created logical clarifications and explanations of the myths—theologies—arose only in the past few thousand years after the emergence of writing and of extensive logical purification of linguistic symbols and the emergence of their successful use in logical calculations concerning the real world and its future.

In addition to Hoagland's generalization about brain function, which I cited above, there is a wealth of data accumulated by biologists and ethologists, psychologists and psychiatrists, and neurophysiologists and anthropologists to show the selective advantages that led to increasing ritual communication of information and hence increasing selection for the elaborations of the brain cortex in our ancestors during the past several million years, with a recent burst of sociocultural communication and evolution of culturetypes when the neocortex was selected for capacities in linguistic communication. Ritual communication was limited at first to signals sent in the form of bodily behaviors at the level of instincts. Often they were phylogenetically derived response patterns that evolved to become available for intra- and interspecies signals as conspecifics and other creatures evolved to respond to them adaptively. This communication was mediated by the reptilian level of the brain and connects very tightly with our genetic instructions. The power of religion to motivate behavior comes from its contact with the basic motivational mechanisms of our earliest and most basic or genetic nature.[36]

It should be kept in mind that the wealth of ritual communication that is so useful in maintaining our social relations—such as smiles, frowns, and growls—was genetically programmed behavior that had started to evolve more than a hundred million years ago and continued to evolve in our ancestors during the past few million years in the small

anthropoidal kin-group societies. These genetically programmed, lower-brain patterns for ritual emitting and responding to messages from other individuals also were coadapted undoubtedly in more recent evolution with the capacities of our brains to handle the more abstract linguistic forms of communication and with the more complex forms of social life that slowly evolved over the past few hundred thousand years of our hunting and gathering ancestors and into the period when close-kin groups became more extended. The genetic information in this ritual-communication system still must be evolving in coadaptation with the complexities of modern civilizations wherever more viable coadapted symbioses of genetically and culturally transmitted information are being selected over others.

Linguistic communication evolved with new connections between the deeper, genetically more closely programmed layer of the brain and the outer layer where the genetic expression has been adapted to produce mechanisms for processing a more flexible, independent, and highly organized and complex system of symbols not transmitted through the genetic but only in the cultural pool. This bridging within the brain of information from the genotype with that from the culturetype by means of correlated internal associations of a set of words communicated between two or or among two billion brains of widely diverse genetic heritage and also widely diverse nonlinguistic cultural heritage and individual experience gave fantastic new power to man. (Recently, picture books, photographs, motion pictures, and television have been providing a similar revolution for another important channel of communication of meaning developed in another part of the brain—the associations of nonlinguistic visual and sonic patterns that present meanings.) The internal associations of verbal stimuli upon the brain ever retain their connectibility to the basic ritual signals and response patterns, to the deepest emotional feelings and motivations. At the same time the same sets of words are capable of the most refined elaborations of complex meanings of both great literature and abstract science. Hence the brain of any individual becomes the house for a culturetype held in common with a community of other brains inhabiting a societal organism as well as the house of its own unique genetic character and personal experience. Through linguistically transmitted stories or myths elaborated in a long-living societal organism involving thousands or millions of other brains both ancestral and now living, the individual became simultaneously a creature of his genotype and a creature of his culturetype.

Within the past few thousand years, man's linguistic capacities evolved by the selection of the most viable patterns of the phenotypic expressions of the variations of genotypes and culturetypes, the dual

sources of information shaping the behavior of individuals and their societal-organism hosts. Writing emerged to hold verbal forms and associations in stable patterns outside human brains. By 600 B.C. linguistic symbols emerged as so powerful logically that philosophy, geometry, and theology began to flourish, to be followed within a couple of thousand years by modern science, the most phenomenal explosion of information thus far in the history of the earth, pointing to an as yet incipient scientific theology and worldwide religion.

At all levels of the complex symbiotic development of men and societal systems, each adapted to the other in ways that were mutually beneficial as the religious rituals, myths, and theologies evolved to represent progressive, adaptive programs.

Religion early gave correct recognition to the new nature of man. As I have noted, Saint Paul in his classical letters distinguished man's higher spiritual nature (which seems to be related to the aspect of the brain that is informed by the culturetype) from his bodily nature (related to the aspect of the brain informed by the genotype). Insofar as a brain is informed by a culturetype which is well integrated with its genotypic information, then that brain actually incarnates and provides means for the expression of a large fraction of the central values of the total culturetype as well as expresses that brain's particular genotype. The self-consciousness as well as the unconscious phenomena of that brain may be said, in a biological analogy, to be converted into a culturally "identical twin" with all other similarly culturally coadapted brains. Hence it is closer than a merely biological brother to all other brains in the sociocultural system (societal organism) and thus is spiritually (by culturetype) united with the total population of its particular society. To the extent that the genetic program indeed is coadapted with that particular culturetype, then the individual's social and private responsibilities become joined as one, and the individual finds elation in his oneness with all his human spiritual brothers who have become closer than genetic brothers, insofar as his culturetype is identical with that of his fellowmen in a societal organism. The properly enculturated, individual, adult brain becomes the source of consciousness or self-awareness of a new being, transcending its immediate organic body. In this analysis of the evolving material systems that constitute Humanity, we can see that such a consciousness reflects the scientifically described reality involved.

Insofar as the genotypic-culturetypic symbiosis is also well adapted to the total ecosystem, which is the new being's habitat (adaptation to which is the source of life for the new being), the conscious spirit of man is one with all creation. Brains, as coordinating centers of the multiple agencies for adapting, are programmed genetically

and culturally to respond to a recognition of such an adaptation to the total ecosystem by producing an experience of ecstasy followed by a high level of spiritual satisfaction and motivation. Peace, new meaning, moral courage, hope, and related religious experiences or feelings naturally arise whenever the frustrations of a bodily self-centeredness are transformed to a vision of the higher self which transcends the body. These feelings remain or are restored whenever that vision is revalidated in experience.

It is toward the goal of union with or adaptation to the total system of powers underlying man's natural habitat (always including primarily one's fellow human beings involved in the societal organism with which he is symbiotic) that it has been the function of religions to motivate and sustain human beings.

Revitalization of Religious Truth on the Level with Science

In the past few centuries, for increasing numbers of people and societal organisms, there has been a loss in the efficacy of their religions because, for the most part, the religious myths or their more developed theologies (where these had emerged) became disjoined from and incredible among the new sciences. When religion once again becomes updated to constitute a credible vision of an individual's ties with his society and his cosmos, it again will deliver us from our alienation and meaninglessness and engender the cooperative or moral dispositions essential to the coadaptation of the individual *sapiens* symbionts with their societal organism. Although Saint Paul did not have the details that we now have concerning man's two natures and their relation to total nature, our scientific perspective seems to confirm his general analysis and—with some slight corrections and translations to modern equivalents—also his answer to the question of who will deliver me from this body of sin and death.[37]

I immediately must note, however, an important point from the modern scientific picture that transcends in clarity and credibility anything I know of in previous theology. The human spirit (and conscious mind), while indeed a reflection of the body-transcending information of the culturetype whose enculturation in our brain renders us one with our local society and ecosystem, still is primarily dependent upon its genetic information, without which no human individuals or societies of any kind could exist. The human soul and its salvation involve genes as well as idenes. This should help to clear me of any theological charges of gnosticism.

This brings me back to genetics. In order to attract and hold any individual human symbionts to constitute its incarnation, the first

requirement of any societal organism's culturetype is that it promise and deliver greater longevity to the average if not to the bulk of the diverse types of genetic lines assemblable from its gene pool than would be probable from any competing societal organism or ecological niche. In other words, man's immortal substance is of the earth, earthy. The genes are as essential a part as the culture. The significant core or soul of human nature is a phenotypic reality created by the union of three distinct and enduring if not immortal heritages of information that have been coadapted by a selective process. The first is the "information" that structures the stable patterns of our earthly habitat. The second is the information in the gene pool, coadapted with or reflecting that of the physical habitat, which, in the context of the habitat, engenders biological organisms and ecosystems. The third, coadapted with the previous two, is our heritage of culturetypic information, which, in the context of the previous two, engenders human societies, civilizations, and ecosystems.

It is on the basis of the evolutionary role of religion that I have made my prophecy of its revitalization in a new stage of cultural evolution. In that stage theology no longer will be the deceased queen of the Greco-Roman heritage of the scientiae of the medieval period but will become the living queen, resurrected by new interpretations in the light of the modern sciences—queen not because she is the primary source of truth but queen because she is the primary application of truth to the matters that are of greatest significance or ultimate concern to men.

In "Natural Selection and God" and related papers I took "natural selection" and "God" quite seriously in their own cultural contexts and sought to translate between scientific and religious language to show what I considered to be their essentially analogous meanings.[38] The Jesuit Father Pierre Teilhard de Chardin, as a paleontologist, earlier had felt an equivalence between our evolutionary understanding of the creation and sustenance of man and the traditional religious and theological efforts to represent man's state in the scheme of things. While no individual or group yet has come up with a formulation completely acceptable in all points to the majorities in either the religious or the scientific communities, it seems clear that both communities concur that, while, in order to remain in being, man himself must cooperate actively in the program of creative evolution, in the end it is a system of creative power far transcending man that determines man's destiny, a self-creating selective system which has endowed man with the desire to cooperate with or adapt to it. It seems clear from the scientific pictures that man's chief end is to seek the requirements of the ultimate reality system and adapt to them—at

least if he wants to continue as a body-transcending or body-transforming being on the outer envelope of the evolving systems of life on earth.

While, in present Western culture, the religious images or models of man's immortal nature and purpose largely have been dismissed, I have sought to show how information from various scientific disciplines is building up a picture of the immortal or "spiritual" realities at the core of *Homo's* phenotype, including those of which he is unconscious as well as those of which he is aware.

Without going into an analysis of the relation between conscious and unconscious elements of reality,[39] I would suggest here that the evolution of human consciousness—the production of awareness of relations among elements of self and the world—is a product of the symbiotic action of genotype and culturetype interacting with cosmotypes (the recurrent patterns of the human habitat) in shaping the brain and its behavior. Consciousness is a reflected image of creation. It is a product of a particular brain's internal behavior in its dynamic play with the system of symbols and mechanisms or strategies for playing that it has inherited and is currently being fed in the game of the continuing creation of life. In general the consciousness produced by the brain reflects or shows only that portion of the phenotype's present situation and potential activities that are likely to be most important for immediate decisions to enhance life. With varying amounts and urgencies of messages before it, consciousness is a judging or selecting mechanism, a temporary and local teleonomic agent empowered by and subject to the wisdom for life already donated to and accumulated in a particular brain. Conscious intent or purpose becomes teleological whenever it discovers what will be selected in the future by the fact that it is a potential stable state under new conditions offered by the universe.

This is the teleology to which I already have referred as so eloquently expressed by Bronowski in his picture of our universe as containing hidden preferences that chance or random variations sooner or later discover and bring into being as new levels of stability. Unfortunately, Jacques Monod and many others passed away before recognizing what Bronowski recognized a few years before: "There is therefore a peculiar irony in the vitalist claim that *the progress of evolution from simple to complex* cannot be the work of chance. On the contrary, as we see, exactly this *is how chance works, and is constrained to work by its nature.* The total potential stability that is hidden in matter can only be evoked in steps, each higher layer resting on the layer below it. The stable units that compose one layer are the raw material for random encounters which will produce higher configurations, some

of which will chance to be stable. So long as there remains a potential of stability which has not become actual, there is no other way for chance to go."[40] This is similar to pictures presented by Simon, George Wald, and a number of others concerning the evolutionary process of the world.[41]

That the nature that selects in this expanded picture of natural selection is very much like some of the traditional gods, as far as man's proper aspirations and duties are concerned, seems increasingly clear. That such a nature or god demands and in fact insists on individual man's cooperative service to and union with his fellow man and with the requirements of the ultimate nature of reality (which is a proper translation of God) is another name for the whole picture of evolution: adaptation.

NOTES

1. Herbert A. Simon, "The Architecture of Complexity," *Proceedings of the American Philosophical Society* 106 (1962): 467–82 (reprinted in his *The Sciences of the Artificial* [Cambridge, Mass.: M.I.T. Press, 1969]); Howard H. Pattee, ed., *Hierarchy Theory: The Challenge of Complex Systems* (New York: George Braziller, Inc., 1973).

2. J. Bronowski, "New Concepts in the Evolution of Complexity: Stratified Stability and Unbounded Plans," *Zygon* 5 (1970): 18–35; Ralph Wendell Burhoe, "The Control of Behavior: Human and Environmental," *Journal of Environmental Health* 35 (1972): 247–58; idem, "The Civilization of the Future: Ideals and Possibility," *Philosophy Forum* 13 (1973): 149–77; idem, "The Human Prospect and the 'Lord of History,' " *Zygon* 10 (1975): 299–375.

3. B. F. Skinner, "The Phylogeny and Ontogeny of Behavior," *Science* 153 (1966): 1205–13.

4. Donald T. Campbell, "On the Conflicts between Biological and Social Evolution and between Psychology and Moral Tradition," in this issue and in *American Psychologist* (December 1975), pp. 1103–26.

5. See my "Human Prospect," p. 326.

6. R. W. Sperry, "Science and the Problem of Values," *Zygon* 9 (1974): 7–21.

7. E. O. Wilson, *Sociobiology: The New Synthesis* (Cambridge, Mass.: Harvard University Press, Belknap Press, 1975); cf. e.g., pp. 159, 575.

8. Hudson Hoagland, "The Brain and Crises in Human Values," *Zygon* 1 (1966): 140–57.

9. The literature is large, complex, and unfinished, but a good introduction is Konrad Lorenz's *On Aggression* (New York: Harcourt, Brace & World, 1966), and, for moral development, see Lawrence Kohlberg, "Indoctrination versus Relativity in Value Education," *Zygon* 6 (1971): 285–310. In my "Human Prospect," in the section "Ancient Biological Roots of Religion," pp. 304–12, I gave a different treatment and cited several workers in the field. George Edgin Pugh has described the role of the brain in human decision systems in "Human Values, Free Will, and the Conscious Mind," *Zygon* 11 (1976): 2–24. A larger treatment of human values appears in his *On the Origin of Human Values* (New York: Basic Books, 1976) and provides many details that parallel my own development of this field.

10. Paul D. MacLean, "The Brain's Generation Gap: Some Human Implications," *Zygon* 8 (1973): 113–27.

11. Ibid., p. 120.

12. George C. Williams, *Adaptation and Natural Selection* (Princeton, N.J.: Princeton University Press, 1966), p. 95. For Wilson, see n. 7 above.

13. Campbell.
14. See n. 12 above, p. 93.
15. Ibid.
16. Ibid., p. 121.
17. Ralph Wendell Burhoe, "Natural Selection and God," *Zygon* 7 (1972): 30–63.
18. Williams, p. 94. Robert L. Trivers's development is found in his "The Evolution of Reciprocal Altruism," *Quarterly Review of Biology* 46 (1971): 35–57.
19. I am great indebted to Emerson's "Dynamic Homeostasis: A Unifying Principle in Organic, Social, and Ethical Evolution," *Scientific Monthly* 78 (1954): 67–85 (reprinted with some revision in *Zygon* 3 [1968]: 129–68).
20. Alfred E. Emerson, "Ecology, Evolution and Society," *American Naturalist* 77 (1943): 117–18. He presents a more recent summary of "Reciprocal Phylogeny of Host Rhinotermitidae and Associated Organisms" including a section on "Evolution of Ecosystems" in his "Tertiary Fossil Species of the Rhinotermitidae (Isoptera), Phylogeny of Genera, and Reciprocal Phylogeny of Associated Flagellata (Protozoa) and the Staphylinidae (Coleoptera)," *Bulletin of the American Museum of Natural History* 146 (1971): 245–303. Two more readily accessible papers by Emerson provide details on population systems, intraspecies supraorganisms, and interspecies ecological supra-organisms, etc.: (1) his chaps. 24 and 33–35 in W. C. Allee et al., *Principles of Animal Ecology* (Philadelphia: W. B. Saunders Co., 1949) and (2) his "The Evolution of Adaptation in Population Systems," in *The Evolution of Life,* Evolution after Darwin: University of Chicago Centennial, 3 vols., ed. Sol Tax (Chicago: University of Chicago Press, 1960), 1:307–48. Incidentally, the three volumes in the series contain many papers pertinent to the proposals I am making concerning the relation of genetic and cultural evolution.
21. Williams, chap. 4, esp. p. 97.
22. For genetic selection as one of many mechanisms involved in stabilizing (remembering, maintaining, and reproducing) the patterns of life, see, for instance, John H. Holland, *Adaptation in Natural and Artificial Systems* (Ann Arbor: University of Michigan Press, 1975), or Simon's *Sciences of the Artificial* (n. 1 above). For living systems as guided patterns of energy flow, see, for instance, A. Katchalsky, "Thermodynamics of Flow and Biological Organization," *Zygon* 6 (1971): 99–125.
23. Howard T. Odum, *Environment, Power, and Society* (New York: Wiley-Interscience, 1971).
24. Bronowski (n. 2 above), pp. 30–31. See also my note at the bottom of p. 39 of my "Commentary" on Bronowski's paper, which he insisted I publish with it (*Zygon* 5 [1970]: 36–40): "Bronowski, in his concept of 'stratified stability,' has at last given a neat physical formulation that underlies all levels of the selective or adaptive process in evolution from atoms to human cultural patterns."
25. I was reminded of the extrachromosomal information in eucaryotic cells found in mitochondria, plastids, etc., by Emerson in a personal communication, expressing the view that some recent evidence was indicating that such cells were indeed symbiotic ecosystems akin to the views I am developing in this paper. I am not yet familiar with the literature of this field, although in an unpublished paper I have cited John C. Kendrew's brief remarks on it found on p. 193 of his paper cited in n. 33 below. The role of hierarchy is set forth in the papers edited by Howard H. Pattee (see n. 1 above). The quotation from Simon is from his *Sciences of the Artificial,* pp. 23–24.
26. Unpublished ms.; but see p. 364 of my "Human Prospect" for a review, and the whole paper for a certain development of the theme.
27. For a picture of the reemergence of notions of cultural evolution, see, for instance, Hudson Hoagland and Ralph Wendell Burhoe, eds., *Evolution and Man's Progress* (New York: Columbia University Press, 1962). Also, see passim in vols. 2 and 3 of Tax (n. 20 above).
28. Wilson (n. 7 above), p. 380.
29. Ibid., p. 386.
30. Ralph Wendell Burhoe, "Evolving Cybernetic Machinery and Human Values," *Zygon* 7 (1972): 188–209.

31. Manuscript record of the Symposia on Evolution and Man's Future, American Academy of Arts and Sciences, 1960.

32. Robert Boyd and Peter J. Richerson, "A Simple Dual Inheritance Model of the Conflict between Social and Biological Evolution," in this issue.

33. John C. Kendrew, "Information and Conformation in Biology," in *Structural Chemistry and Molecular Biology,* ed. Alexander Rich and Norman Davidson (San Francisco: W. H. Freeman & Co., 1968), p. 193.

34. The quotation from Julian Huxley is from the University of Chicago [Darwin] centennial discussions, *Issues in Evolution,* Evolution after Darwin (n. 20 above), 3:213. The similar notions of H. J. Muller are found in his "Guidance of Human Evolution," in *The Evolution of Man: Mind, Culture, and Society,* Evolution after Darwin, 2:423–62, passim.

35. Emerson (n. 19 above).

36. Examples of scientists in whose writings the theory and supporting data for this picture of ritual behavior and the lower brain are, among biologists and ethologists, such persons as Dobzhansky, Wilson, Williams, C. H. Waddington, Niko Tinbergen, and Lorenz. Among anthropologists are such as Wallace, Ward H. Goodenough, Solomon H. Katz, and Clifford Geertz. Among psychologists are such as Eugene G. d'Aquili, Murray, and O. Hobert Mowrer. Among neurophysiologists are such as Jose M. R. Delgado, Hoagland, MacLean, Karl Pribram, and Sperry. These in many cases have published in past issues of *Zygon.* Others are publishing in this and future issues. The evidence for this conjoint evolution of genes and cultures and the role of religion has been piling up in the past couple of decades. The evidence for ritual communication originating more than a hundred million years ago is found in Lorenz's *On Aggression* (n. 9 above).

37. See, for instance, my "Natural Selection and God" (n. 17 above), or "The Concepts of God and Soul in a Scientific View of Human Purpose" (*Zygon* 8 [1973]: 412–42), or "Human Prospect" (n. 2 above).

38. N. 17 above.

39. My analysis of the relation of conscious and unconscious is akin to that of Erwin Schrödinger, P. W. Bridgman, and Sperry.

40. Bronowski (n. 2 above), p. 32. See also the confusion in Jacques Monod's *Chance and Necessity,* trans. Austryn Wainhouse (New York: Alfred A. Knopf, Inc., 1971), which Bronowski reduces.

41. See, for instance, Simon's *Sciences of the Artificial* (n. 1 above) or George Wald's "The Search for Common Ground" (*Zygon* 1 [1966]: 43–49).